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UNDERSTANDING INDIAN AGRICULTURAL R&D

Neha Mathur

Assistant Professor, Lakshmibai College, University of Delhi.

ABSTRACT

This paper looks into a generally overlooked area in agriculture sector which is agricultural R&D and tries to understand the evolving objectives, agendas, structure, shortcomings and ways to advance the agricultural research scenario in India. It also attempts to bring focus on analytical studies measuring the benefits of research on Total factor productivity growth in major crops in the agriculture sector. This is primarily fundamental in the face of the ongoing debate in policy circles which interrogates the effectiveness and role of research to the agricultural sector growth.

KEY WORDS: Agricultural R&D, ICAR, TFP, Public sector, Private sector.

Introduction:
For stable and inclusive economic growth in India, growth in the agricultural sector is critical as more than half of the population depends on the agricultural sector for their livelihood. Though post-1960s India has attained remarkable growth in agricultural production, and in meeting the challenges of food security and reducing poverty, but the agricultural sector still faces crucial challenges. Growth of the sector continues to lag behind the desired four percent, and poverty and malnutrition remain widespread.

Key challenges facing the sector are raising the yields and production, achieving food security, increasing resilience of the agriculture sector, meeting the growing and diversifying food demand, managing natural resources sustainably, and preserving the environment.

In this regard this paper attempts to understand the role of Agriculture research in India in pushing agricultural sector towards growth and in meeting the above gaps in the development process.

The most basic objective of research in agriculture is to shift the underlying production process which leads to increase in production and bridging of the yield-gap possible in the respective climatic zone.

However, in coming times the agricultural sector research needs to manage not just one but multiple objectives ranging from food security to serving a more liberalized economy, meeting the needs of diversification, as well as climate change and environment concerns. And moreover reaching and maintaining a balance between these objectives constitutes a major challenge in itself.

This paper is organized as follows: Section 1 looks briefly at the history of agriculture research in India and the evolution of policy agenda and research priorities over time. Section 2 looks at the present public and private structure of agriculture research in India. Section 3 attempts to respond to the debate in policy circles which questions the effectiveness and role of research to the agricultural sector growth. Section 4 briefly looks at the Indian R&D in global context. Section 5 addresses the shortcomings and way forward in agricultural research in India. And finally Section 6 concludes the paper.

Section I: History and Evolution of Research agenda
Beginning of R&D activities in India can be traced back to the setting up of Department of Agriculture in all Indian provinces in 1880 under the British rule. This was followed by the formation of Imperial Agricultural Research Institute under Montague–Chelmsford Reform (1919).

Post independence, Indian Council of Agricultural Research (ICAR) was established at the Centre and number of State Agricultural Universities (SAUs) were set up at the state level.

ICAR at the national level is responsible for coordinating, directing, and recommending agricultural research and education in the country. Similarly, State Agricultural Universities are accountable for doing the same at the state level.

Evolution of Agricultural R&D in India:
The agenda of Agriculture research in India can be seen by dividing it in the following time periods:

1. Begging Bowl to Food Self-Sufficiency (Green Revolution): 1950– 1970
During the period from 1950 to 1970, India faced droughts and floods; and with increasing population, shortage of food was the main policy concern and development priority of the government. Increasing productivity of food crops was the main policy agenda and research priority as well.

However, the pattern of growth in agriculture has brought in its wake uneven development across regions (for example, dry-land areas bypassed) and crops (most commonly rice and wheat) as well as among farmers (small and marginal farmers, agricultural laborers) and natural resources degradation (soil, land and water) in several areas.

Beyond the Green Revolution: 1970–1990
During the next period, 1970–1990, in view of the above policy concerns, the agenda and research priorities emphasized conservation and improvement of genetic resources to raise productivity, H.Y.V. seeds for more crops like paddy, pulses and oilseeds, sustainable natural resource management, diversification, postharvest management, human resource development (HRD), and infrastructure strengthening at the research stations.

During this period, it is essential to note the NARS's contribution to usher in milk, egg, fruit and vegetable, fish, and oilseeds revolution.

2. Economic Reforms: 1990–2000
During 1990–2000, India introduced macroeconomic reforms and trade liberalization. Globalization following the formation of the WTO exposed the hitherto-protected Indian agriculture to the world.

During this period India witnessed deceleration in productivity, economic reforms were minimal in agriculture, low agricultural exports, the rate of decline in poverty slowed, malnutrition increased, further strain on natural resources was reported, climate change effects became more visible, and the energy problem became acute.

There were talks of a second Green Revolution during this time. For this, it was necessary to turn the unproductive zones productive. A good percentage of total plan outlay was allocated to agricultural sector.

The research agenda and priorities of the national research system included dry land horticulture, ideal cropping systems, public/private–sector partnerships (PPPs), HRD, and strengthening frontline extension activities through further expansion of KVKs.

Emphasis was also laid on tapping new technologies in the field of molecular biology, biochemistry, GIS, remote sensing etc.

3. Revival of Agriculture: 2000–2011
During the period from 2000 to 2011, the dominance of the agricultural market was sorely evident amid production failures. National policy concerns of this period included high price volatility; shortage of food.

To address the agrarian crisis identified with increasing rates of farmer suicides, the National Policy for Farmers (NPF) was formulated to increase the net income of farmers.

The NARS policy agenda and research priorities included the development and diffusion of agricultural technologies, more efforts in biotechnology, strengthening research in NRM and climate change, PPP, and more international collaborations.

4. 12th Five-Year Plan: 2012–2017

Currently, the main national policy concerns and development priorities reflected in the government's planning documents include addressing rising and highly volatile commodity prices, declining and degrading natural resources, threats of climate change, energy security, food insecurity, malnutrition.

The policy plan and research concerns to address these policy concerns include enhancing productivity, input use efficiency and profitability in farming, promotion of climate-smart agriculture, secondary agriculture, and development of quality human resources.

Section II Structure:

(i) Public Sector R&D

The Indian Council of Agricultural Research (ICAR) at the Centre and the State Agricultural Universities (SAUs) in the states primarily constitutes the public agricultural research system in the country.

The Indian agricultural research system has close ties with International organizations as well such as the CGIAR centers namely ICRISAT, IFPRI, and other international centers also have strong ties with However, since independence and till now the percent of agricultural GDP spent on agricultural research has not even reached 1%. This implies that no special efforts in the policy making have been made to raise the spending on agricultural research.

In contrast to the above, the developed countries spend on average around 2 percent or more of agricultural GDP on agricultural research.

Table 1: Share of Agricultural Research in the Agricultural GDP through Different Five-Year Plans

Plan (Period)	Share in the agricultural GDP (%)
Fourth Plan (1969-74)	0.22
Fifth Plan (1974-78)	0.29
Sixth Plan (1980-85)	0.35
Seventh Plan (1985-90)	0.46
Eighth Plan (1992-97)	0.46
Ninth Plan (1997-02)	0.80
Tenth Plan (2002-07)	0.59
Eleventh Plan (2007-12)	0.70

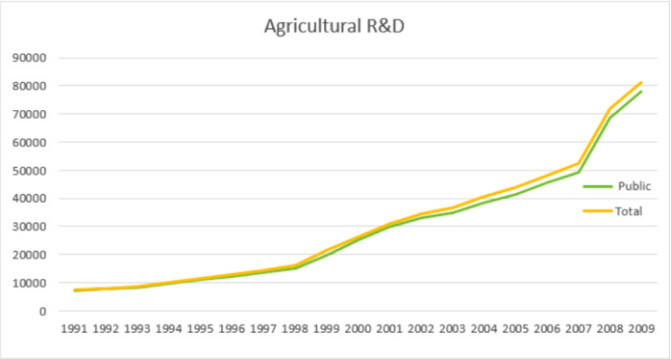
Source: *ICAR Report, 12th Plan Document*

(ii) Private Sector R&D

The private sector research scenario in India has got interested with the entry of MNCs. Most of them have entered the industries such as seed, agrochemicals, fertilizers, and agricultural machinery where it is more profitable. This has been possible particularly due to the globalization of the country and the strengthening of the IPRs.

The private research investment expenditure has been on a continuing rise. But its share in the total research expenditure is still very low compared to the public sector as can be seen from the chart below.

Chart 1: Investment in agricultural R&D: Public sector and Total (in million Rs. at current prices)



Source: *C. Ramasamy (2013).*

Section III Measuring benefits from Agricultural Research:

The principal anticipated benefit from agricultural research is to increase productivity and production in the agricultural sector.

Infact in the past decades the production of foodgrains such as rice and wheat, oilseeds, sugarcane, cotton has risen manifold.

The increase in food production has helped India to face the problem of food security. With this it has also been able to change its from a net importer to a net exporter since many years.

However, rigorous studies of how much research is contributing to total factor productivity(TFP) growth are scarce. There is a need to study closely the factors bringing in the TFP growth. This way we can get more clarity on the effect of agricultural research on TFP. It is particularly essential in the face of the ongoing debate in policy circles which interrogates the effectiveness and role of research to the agricultural sector growth.

A paper by Ramesh Chand et al. (2011) recognizing above, attempted to investigate how much of the TFP growth can be attributed to research activities.

TFP indices for major crops grown in different states of India can be computed using Divisia Tornqvist index.

Further to gauge the variables on which TFP growth, we can regress the TFP indices on variables such as research, extension, infrastructure variables, natural resources.

The study by Ramesh Chand et al. (2011) revealed that the public research has been a significant source of TFP growth in most of the crops. This information is important for prioritizing public research activities in policy making.

The regression coefficients of research stock can be used to measure elasticity of TFP with respect to research stock and to assess its impact on TFPG. The elasticity of TFP with respect to research stock ranged from 0.0185 for groundnut to 0.1933 for red gram (Table 3).

The inverse of this elasticity gives research stock flexibility which represents the required increase in research stock to increase in TFP by 1 per cent. These estimates show that to achieve 1 per cent increase in TFP, the investments in research need to be increased by 21.5 per cent for rice, 19.5 per cent for wheat and similarly for other crops.

Table 3. Elasticity of TFP with respect to research stock for major crops in India

Crop	TFP elasticity with respect to research stock			Research stock flexibility (%)
	Model 1	Model 2	Average	
Rice	0.0454	0.0469	0.0465	21.5
Wheat	0.0513	0.0514	0.0513	19.5
Maize	0.0728	0.0743	0.0734	13.6
Sorghum	0.1128	0.1183	0.1155	8.7
Pearl millet	0.0514	0.0524	0.0519	19.3
Chickpea	0.0986	0.0884	0.0935	10.7
Red gram	0.2148	0.1717	0.1933	5.2
Groundnut	0.0178	0.0192	0.0185	54.1
Rapeseed & mustard	0.0429	0.0505	0.0467	21.4
Cotton	0.0716	0.0857	0.0786	12.7

Source: *Ramesh Chand et al. (2011)*

Contribution of agricultural research to TFP is a strong reason for pushing research activities in the agriculture sector.

Section IV: Indian Agricultural R&D in Global context:

When we compare the yield of major crops vis-à-vis other countries as in Table 4, we can notice wide ranging gaps. In fact, within India but across different states, the yields vary widely, showing that there are immense possibilities of increasing yield of most of the crops without pushing up the prices.

Table 4: Crop Yield Comparison - India versus the World

Crop	All India Average	India Highest Yield (State)	World Highest Yield
Paddy	2416	Punjab - 3952	China - 6661
Wheat	3415	Punjab - 5017	UK - 7360
Maize	2676	Tamil Nadu - 5372	USA - 8858
Chickpeas	960	Andhra Pradesh - 1439	Ethiopia - 1663
Cotton	510	Punjab - 750	Australia - 1920
Rapeseed/Mustard Seed	1185	Gujarat - 1723	UK – 3588

Source: *Economic Survey 2014-15*

In terms of Public Agricultural R&D spending and intensity ratio as seen from Table 5 below, India has invested $0.40 for every $100 of Agricultural GDP in 2008. This is less than China's. Moreover, Asia's high- income nations as well as Brazil have invested much greater shares of their Agricultural GDP in agricul-

tural R&D, varying from $1.80 for Brazil to $4.75 for Japan.

Table 5: Public Agricultural R&D spending and intensity ratio

Countries	(billion 2005 PPP prices)		($ per 100$ of Agricultural GDP)	
	2000	2008	2000	2008
India	1.5	2.3	0.36	0.4
Brazil	1.2	1.3	1.86	1.8
China	1.7	3.4	0.38	0.5
Japan	2.6	2.7	4.06	4.75
South Korea	0.6	0.7	1.6	2.30

Source: *Pal et al (2012).*

Section V:
Shortcomings:
Despite several successes, Agricultural R&D still has a lot of scope to contribute to the agricultural sector and assist it in overcoming the numerous challenges that the sector faces even today.

Farming as an occupation is not attractive and in fact its economic viability is deteriorating over time. This can be seen from the rising agrarian distress and the soaring farmers' suicides.

In fact, the goals of Agricultural Research have not kept pace with time. It is still majorly directed towards the objective of increasing food productivity and production much to the neglect of broader objectives such as improving efficiency, reducing costs, development of frontier sciences, environment preservation, institutional innovation, social inclusion and others. The globalization of agriculture sector since 1990s has further pressed the need for tuning research in view of meeting the commercial needs of the sector.

Private Research has grown rapidly in the recent past, especially with the entry of multinationals. But public system has not responded to this. Areas of comparative advantage have not been charted out. No systematic compilation of research is in place.

Further, public research system is plagued with misallocation of resources, poor monitoring and performance evaluation, duplication in research, and bureaucratic rigors.

The Way Forward:

(i) There is a need to stimulate the existing agricultural R&D System. Agricultural growth will critically depend on R&D as emphasized in the National Agricultural Policy (NAP), 2000. It has also emphasized on the new paradigm of regionalization of research based on well-defined agro-climatic regions, application of frontier sciences, participatory and proprietary approaches in R&D, strengthening research–extension linkages, and a well-organized, efficient, and result-oriented agricultural R&D system.

(ii) The public agricultural R&D systems need to be shaped into an innovative system structure. The bureaucratic system needs to be made a more flexible and liberal system of administration. The redundant centers may be closed down. The scientists can be instructed on business skills and other knowledge.

The system of assessing the performance of ICAR institutes needs to be thoroughly examined in the context of new developments.

There is a heavy need of bringing in an assessment culture in agricultural innovation system in India. This is required to remain posted about the impacts of the released technologies, on the way these research programs are perceived, and how the programs are conducted.

(iii) Public–Private Partnerships should be explored to use limited resources to their maximum advantage.

Also overall there is a need for researchers, farmers and extensionists to come together with location-specific technologies that are scientifically sound, socially appropriate and environmentally relevant.

(iv) Further in view of deriving benefits under the WTO regime a targeted approach which accords adequate attention to export commodities and frontier sciences so as to reduce cost and improve quality is needed.

Section VI: Conclusion
As discussed above the agricultural R&D in India needs to serve multitude of objectives so as to serve the agricultural sector which is in dire needs of a stable and over 4% growth and on which depends over 50% of the population for livelihood. These objectives range from the food security goal of providing physical, economic and ecological access to food and in making the country self- sufficient in food grains and also a big exporter of agricultural commodities.

In order to achieve the above objectives, our agriculture research system has to finely balance the different and conflicting objectives. Not all research can fit into a single mode of approach. There is a need to support and not compete with the private sector, pushing its competitiveness in global markets but at the same time not displacing the small scale producers. There is a need to adopt and develop frontier sciences while simultaneously adapting research for traditional and subsistence sectors. Along this there are agendas of climate change and environment preservation; social inclusion; gender equity issues; poverty reduction and malnutrition reduction.

And to achieve all above it is crucial to overhaul the public research institutions in spheres of efficiency, human resource development and consolidating PPP wherever it is more advantageous. Policy setting must serve as a stimulant to achieve the goal of enlarging the benefits of agricultural R&D.

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